SWRHL-17r

FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE KIWI TNT EXPERIMENT

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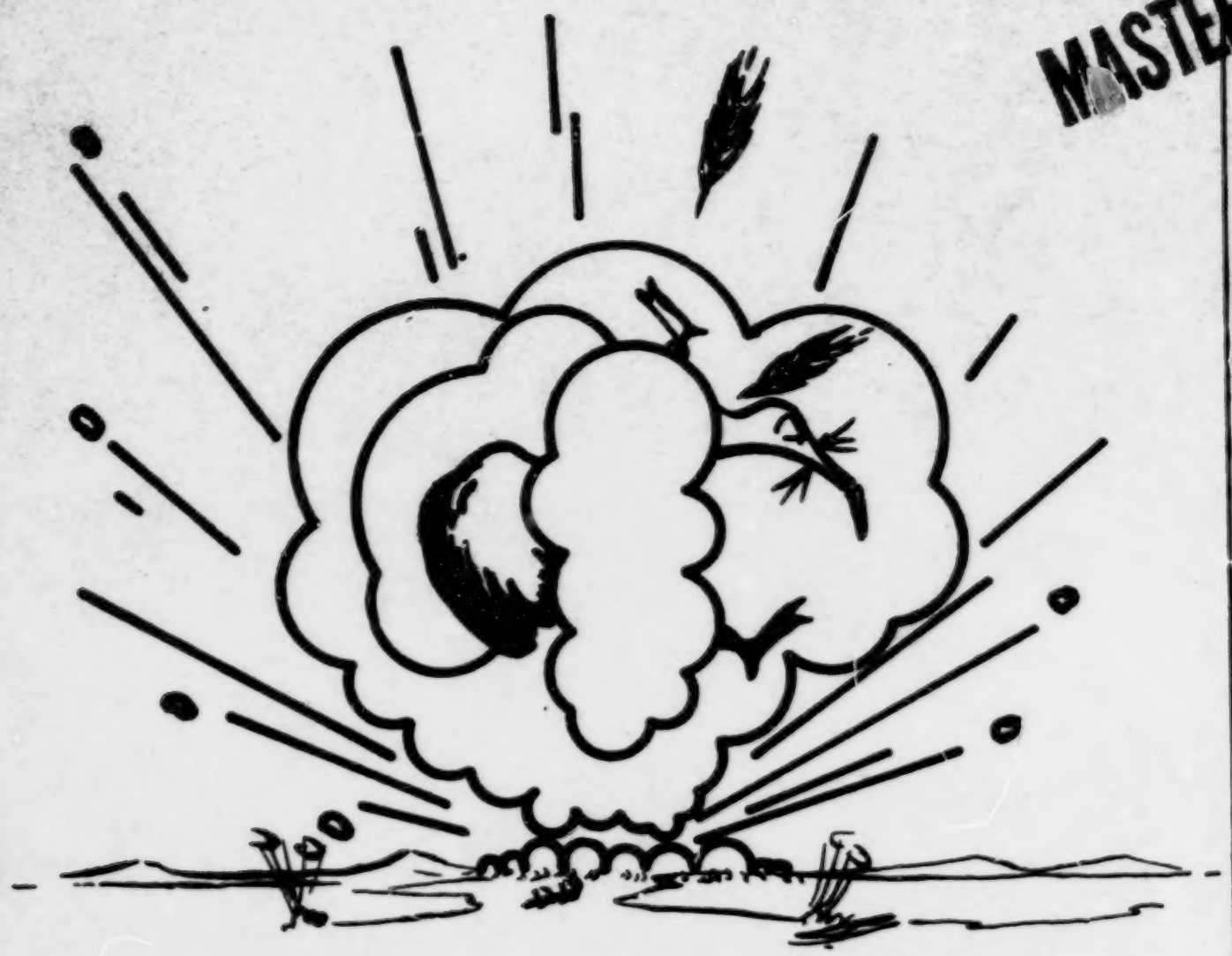

August 6, 1965

by the
Southwestern Radiological Health Laboratory
U. S. Public Health Service
Department of Health, Education, and Welfare
Las Vegas, Nevada

This surveillance performed under a Memorandum of Understanding (No. SF 54 373) for the U. S. ATOMIC ENERGY COMMISSION

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The South
radiation
(TNT) con
tracking t
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California
Kiwi TNT
exceed Ra
Commissi

ABSTRACT

adiological Health Laboratory provided off-site
ce in support of the Kiwi Transient Nuclear Test
January 12, 1965. This support consisted of
, monitoring radiation dosage to the off-site pop-
g environmental samples in southern Nevada and
h off-site contamination occurred as a result of
collected indicate that radioactivity levels did not
otection Guides established by the Atomic Energy
off-site population.

ABSTRACT
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LIST OF TA
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III. RESUL
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E. W
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On January 12,
ducted at 1058 h
Development Sta
signed to determ
Kiwi reactor an
on both accounts
reactor accident

Under a Memor
mission (AEC),
gram of radiolo
off-site area su
Range. The ove
Nellis Air Forc
ment Station (N
plicity will be c

I. INTRODUCTION

Kiwi Transient Nuclear Test (TNT) was con-
at Test Cell C, located at the Nuclear Rocket
kass Flats, Nevada. The experiment was de-
ffect of rapid control drum rotation within a
re of the subsequent fallout. Data collected
in predicting the effects of postulated Kiwi

Understanding with the Atomic Energy Com-
Public Health Service (PHS) conducts a pro-
itoring and environmental sampling in the
the Nevada Test Site and the Nellis Air Force
plex of the Nevada Test Site (NTS) and the
NAFR) includes the Nuclear Rocket Develop-
the Tonopah Test Range (TTR) and for sim-
test range complex throughout this report.

BLA

L PROCEDURES

tracked the cloud passage with
nitor was equipped with an Eber-
111 "Scintillator", and a Victoreen
R.

e of 0 to 200 milliroentgens per
an external halogen filled GM tube
n an internal Anton 302 tube. The
r" is used primarily for low level
ge of 0 to 5 mr/hr in six scales.
50,000 mr/hr on two scales.
t gas ionization chamber. Errors
ese instruments are of the order

ders were placed at eight locations
ed wind sector (240° ±20°). (See
ion to 19 routine stations in opera-
lex. The recorders utilize a Geiger
a dose rates at specific locations.
trument has a 0.01 - 100 mr/hr
0 hours. The RM-11 is accurate
Cs source.

Film Badges

Film badges were issued to
Wells, 30 in the Amargosa F
Junction. Nine of the routin
the downwind sector. The ba
which is accurate to ± 50% in
in the 100 to 2000 mr range.
is 20 mr.

Aerial Cloud Tracking

An Air Force U3-A aircraft,
tracked the reactor effluent.
to position ground monitors
PHS planes containing sampl
aids in cloud tracking. Thei
cloud sampling in order to de
The results of their samplin
PHS-SWRHL Engineering De

B. Environmental Measurement

Air Samples

Forty-five routine air sampl
Arizona and California. Sup
Kiwi TNT experiment, were
Figure 1 shows the 18 sampl
samplers which are located i
were equipped with Whatman
cartridges. All air sample p
collected following Kiwi TNT
Radiological Health Laborato

ople including 67 at Lathrop
rea, and 5 at Death Valley
on film badges were in or near
sed is Du Pont type 555 film
0 to 100 mr range and ± 10%
ower limit of detectability

ed by two PHS monitors,
l dose rate readings served
test range complex. Two
ipment were also used as
ary purpose, however, was
ne cloud size and inventory.
eported separately by the
ent Program.

e operated in Nevada, Utah,
tary air samplers, for the
at 18 downwind locations.
s the five routine air
area. All of these samplers
efilters and MSA charcoal
rs and charcoal cartridges
returned to the Southwestern
RHL) in Las Vegas, for analysis.

A gross gamma counting system was utilized to quickly determine which samples had activity above background and consequently delineate those areas which required additional sampling.

The prefilters were counted for gross beta and alpha activity with a Beckman wide beta proportional counter connected to a high speed scaler. This system has a detection efficiency of 45% for beta particles from strontium 90 decay (maximum energy = 0.54 Mev) and has a background of 6 $\pm$ 1 counts per minute.

All air samples were counted for gross beta activity as soon as possible after receipt at SWRHL. Samples which indicated beta concentrations in excess of 20 pCi/M^3 were recounted frequently within the following 48 hour period. These samples were then held for routine counts at 5 and 12 days after collection. The computational procedure employed depends upon the assumption that a decay constant can be found for each individual sample and that this decay constant can then be used to extrapolate the activity to the end of the collection period. For this purpose the general decay equation $A/Ao = e^{-\lambda t}$ is employed. For samples showing less than 10 pCi/M^3 at time of first count, the 5 and 12 day counts are utilized for computing the decay factor. For sample concentrations exceeding the 10 pCi/M^3 the earlier counts are used for extrapolation purposes. It is frequently impossible to allow samples to remain uncounted until the natural activity has decayed, as this will also result in the decay of all fission product activity. As a result, it is occasionally found that natural radon and thoron activity is not negligible relative to the fission product activity. This will be particularly true of special samples having up to 20 pCi/M^3

when the first count is within a few hours after collection. No allowance is made for the presence of this natural activity and the corrected values are therefore in error on the high side. Natural activity generally is less than 1 pCi/M^3.

All charcoal cartridges and prefilters were analyzed for gamma isotopes by placing each directly on a 4" x 4" sodium iodide crystal coupled to a 400-channel pulse height analyzer set to view energies from 0 to 2 Mev. The activity on the cartridge should represent the gaseous fission products such as isotopes of iodine. Overall detection efficiency for this geometry is about 18% at 0.53 Mev (^{133}I). The minimum detectable activity for ^{131}I, ^{132}I, ^{133}I, and ^{135}I is about 200 picocuries total on the cartridge with an accuracy, at this level, of $\pm$ 50% for ^{131}I, ^{132}I, ^{133}I, and $\pm$ 100% for ^{135}I. The time of count is 10 minutes. Error estimates are such that values less than 1 picocurie per cubic meter (pCi/M^3) are generally not reported. Since it is not possible to define duration of effluent passage at all locations, the reported values given as pCi/M^3 assume an average concentration over each entire sampling period.

Milk and Water Samples

After each release of activity from NRDS, milk samples are collected from dairies (processing plants), producing dairy farms, and farms producing milk for their own consumption (see Figures 1 and 3). Each sample is counted for 50 minutes. No attempt is made to recount samples giving low positive values. The lower limit of detection for gamma emitters in milk samples is 20 picocuries per liter (pCi/l) at time of count, and all results below that value are reported as <20 pCi/l.

All liquid samples are counted in 3.5 liter inverted well aluminum beakers which are placed on top of a 4" x 4" crystal coupled to a 400-channel gamma pulse height analyzer. Overall detection efficiency for the 0.364 Mev photopeak of ^{131}I is 6.4%. A matrix technique is employed to compute the interference due to the presence of other isotopes. The input to this matrix is variable, allowing for the simultaneous determination of any eight nuclides for which detection efficiencies and interference factors have been obtained. Actual computation is performed by an IBM 1620 computer. When it became evident that no contamination of milk was occurring, the sampling program was stopped on January 21, 1965.

Vegetation samples were obtained at most milk sampling locations. An attempt was made to make the samples representative of the cow's feed; however, the samples were taken primarily as early indicators of where milk might be contaminated and were not intended to yield a cow intake-excretion formula.

III. RESULTS

wi TNT yielded detectable radioactivity off the test range com-
A summary of weather conditions at NRDS on the test day is
ted in Table 1. Data collected following the test indicated a
e bearing lying between 200° and 215° within 50 miles of
DS.

inary flight information received from NATS-EG&G aircraft
ted effluent deposition to the Barstow, California area and
ard to the Pacific Coast. Their data indicate the cloud in the
d, California area at 0100 hours PST on January 13, 1965.
on this information milk samples were obtained at the loca-
shown in Figure 3.

round Monitoring

summary of gamma dose rate data obtained is given in Table 2.
he data indicate a cloud width of approximately 5 miles at
ighway 95, with the east and west edges defined by Lathrop
ells and a location 5 miles west of Lathrop Wells. Further
ownwind, dose rates were found in the Amargosa Desert to
e west of Highway 29. No activity was found as far west as
e Furnace Creek area of Death Valley.

he maximum dose rate measured by a ground monitor off the
st range complex was 70 mr/hr, 1.5 miles west of Lathrop
ells on Highway 95. Based on an integration of the dose rate
ersus time at this location, the external exposure dose, due
cloud passage, was calculated to be 5.7 mr. Although the
cation is normally unpopulated, there were, in addition to
e ground monitor, seven PHS personnel involved in air sam-
ling experiments at this location. A similar calculation was made for

rgosa Farm area and Death Valley Junction; the external dose at these populated locations did not exceed 0.5 mr.

95 was remonitored at 0900 hours on January 13. Re-ontamination was found between Lathrop Wells and a point west of Lathrop Wells on Highway 95. A net peak dose 0.05 mr/hr was found 2.6 miles northwest of Lathrop n Highway 95. Highway 29 and the Amargosa Farm area so remonitored on January 13. There were no readings ackground in these areas.

. Meteorological data, Kiwi TNT, January 12, 1965, obtained from the U. S. Weather Bureau.

dition: Sctd. Hi Sctd., 0.1 Altocumulus, 0.0 Cirrus
ty: Unrestricted
ir data at: Jackass Flats, Nevada 1118 PST, 1/12/65

L)	Wind (deg/kts)	Pressure (mb)	Tempera-ture(°C)	Dew Point (°C)	Relative Humidity (%)
	020/18	893	12.7	0.0	42
	020/19	880	11.0	- 1.1	43
	030/22	855	7.4	- 3.8	45
	030/22	850	7.0	- 3.5	47
	020/18	818	4.1	- 4.4	54
	020/17	788	1.5	- 5.2	61
	030/16	759	- 1.4	- 6.6	68
	040/15	740	- 3.2	- 7.5	72
	040/14	730	- 3.6	- 8.2	70
	030/15	704	- 5.0	-11.0	63
	030/16	700	- 5.1	-11.3	62
	030/17	676	- 6.4	-13.7	56
	050/19	648	- 7.9	-17.0	48
	050/23	632	- 8.8	-18.9	44
	060/24	624	- 9.5	-21.2	38
	060/26	606	-11.0	-27.2	25
	060/26	600	-11.7	MB	(16)
	060/27	576	-14.1	MB	(16)
	060/26	553	-16.6	MB	(17)
	050/26	531	-19.2	MB	(17)
	050/23	511	-21.7	MB	(18)
	---	500	-23.1	MB	(18)

rface MB=motor boating - dewpoint below limitations of instrumentation.

Table 2.

Loc
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3 miles
Wells-
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15.3 mi.
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Death Va

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on Hwy

B. Dos

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and

Cali

Table 3.

Locati
(See Fig

Lathrop

Dansby'

Death Va

tes occurring off the test range complex on 1/12/65.

	Time of peak dose rate (PST)	Time interval in which dose rates greater than Bkg existed	Net peak gamma dose rate (mr/hr)
95 on Lathrop ad(NRDS			
	1143	1130-1207	70
	1146	1125-1148	2.0
rop Wells	1147	1138-1158	70
p Wells	1207	1200-1220	0.18
mi. S of Lath- 29 & 6 mi. W rm Rd.)	1252	1232-1324	0.67
rop Wells	1328	1305-1345	0.28
tion	1349	1315-1428	0.11
h Valley Jct.	1335-1415	1300-1440	0.23

corders

ate recorders recording activity above background

Table 3. Recorders operating at Beatty, Nevada

Wells, Furnace Creek Ranch, and Shoshone,

not indicate activity above background.

te recorder data on 1/12/65.

Time of peak dose rate (PST)	Time interval in which dose rate above Bkg. was observed (PST)	Net peak gamma dose rate (mr/hr)
1146	1120-1250	0.7
1250	1145-1335	0.86
1345	1250-1430	0.28

C. Film

Film

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D. Milk

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Table 4.

LO

Lathrop W

Dansby

llected following the TNT experiment indicated
the detection limit (20 mr).

ilk samples were obtained following Kiwi TNT.
ere collected from two ranches in the Amargosa
ocations in southern California. (See Figures 1
nargosa Desert locations and fourteen California
sampled for approximately one week com-
uary 13. None of the 74 samples collected con-
ie quantities of fresh fission products. Animals
ocation were being fed baled hay; the cows at
ornia were feeding on green chop. Locations
s sampled and the dates the samples were
isted in Table 4.

tion samples from the Saticoy-Fillmore-Newhall,
contained fresh fission products; however, cow
t these locations did not contain detectable
esh fission products. Other vegetation samples
area extending from Barstow to Santa Barbara,
not contain fresh fission products.

Table 4. Milk sam

LOCATION	DATE
Lathrop Wells, Ne Selbach Ranch	1/13/65 1/14/65 1/15/65 1/17/65 1/18/65 1/19/65
Barstow, Californi	
Bakersfield, Calif	
Cantil, California	
Lancaster, Califor	
Glendale, Californ	
Lucerne Valley, C	
Los Angeles, Cali	
Riverside, Califor	

ected for Kiwi TNT, January 12, 1965(cont')

DATE
1/13/65
1/14/65
1/15/65
1/16/65
1/18/65
1/19/65
1/14/65
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1/17/65
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Table 4. Milk s

LOCATIO
Escondido, Cali
San Luis Obispo,
Saticoy, Californ
Newhall, Califor
Fillmore, Califo
Brawley, Califo

E. Water Samp

Water samp
Junction on
California o
fission prod

llected for Kiwi TNT, January 12, 1965(cont')

	DATE
	1/15/65
	1/16/65
	1/18/65
	1/19/65
	1/20/65
	1/21/65
ia	1/14/65
	1/15/65
	1/16/65
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	1/16/65
	1/17/65
	1/18/65
	1/19/65
	1/20/65
	1/21/65

obtained from an open pond at Death Valley
2 and 13 and from an open pond at Shoshone,
13. The samples did not contain fresh

F. Air Samples

Air samples from
ducts as a result
air samplers are
cloud outline. Isc
samples are given

Six air samplers
at an average dist
potential gross be
product of the san
is shown in Figur
stations from Hig
maximum concent
at an azimuth of 2

G. Thyroid Dose Due

Thyroids of sever
Program were co
for iodine uptake
will be reported s
that all doses to t
were due to ^{133}I a
miles west of Lat
70 mr/hr was incl
dose of 3.3 millir
cloud passage, th
assumption is ma
of exposure.

ations contained fresh fission pro-
NT cloud passage. Locations of these
in Figure 2 along with the probable
gross beta analyses of the positive
5.

ating in the Amargosa Farm area
3 miles from the TNT site. The
ion exposure as determined by the
iod and the gross beta concentration
nction of distance of the air sampling
From the curve it appears that the
curred five miles west of Highway 29
the test location.

tion
rs of the Off-Site Radiological Safety
ne PHS Whole Body Counting Facility
TNT. Complete results of this work
; however, it has been determined
were less than 3.3 ± 1 millirad and
nhalation. The monitor located 1.5
s who experienced a dose rate of
ne study and received the peak thyroid
d to the 5.7 mr external dose due to
's thyroid received 9.0 millirad. The
e milliroentgen produces one millirad

H. Beryllium Analysis

Analysis was made of
(See Table 5.) The de
crograms per sample.
limit of detection.

Table 5. Air samples with positive results collected following the Kiwi TNT experiment, January 12, 1965.

Location (See Figure 2)	Sample time On-time off hours PST 1/12/65	Volume Sampled M^3	Analysis of Prefilters for Beryllium	Prefilter average gross beta concentration pCi/M^3 at end of collection	Integrated Air concentration $\frac{pCi\text{-}sec}{M^3}$	Collector*	Gamma pulse height analyses pCi/M^3 at end of collection ^{131}I	^{132}I	^{133}I	^{135}I
Lathrop Wells	1015-1240	45	ND	4.3×10^2	3.74×10^6	P	ND	ND	ND	ND
						C	ND	ND	ND	ND
On Hwy. 95, 1.5 mi W of Lathrop Wells	1045-1220	34	---	2.1×10^5	1.2×10^9	P	6.3×10^2	1.4×10^4	1.3×10^4	6.0×10^3
						C	1.5×10^2	2.1×10^2	2.9×10^2	1.9×10^3
On Hwy. 95, 5 mi W of Lathrop Wells	1100-1530	87	ND	8.7	1.41×10^5	P	ND	2.5	3.2	ND
						C	ND	ND	ND	ND
On Hwy. 29, 7 mi S of Lathrop Wells	0800-1435	130	---	1.3×10^3	3.08×10^7	P	ND	1.2×10^2	1.2×10^2	40
						C	ND	4.3	3.5	18

ters for beryllium following TNT.
nit in the analyses was 0.025 mi-
ples analyzed were below the

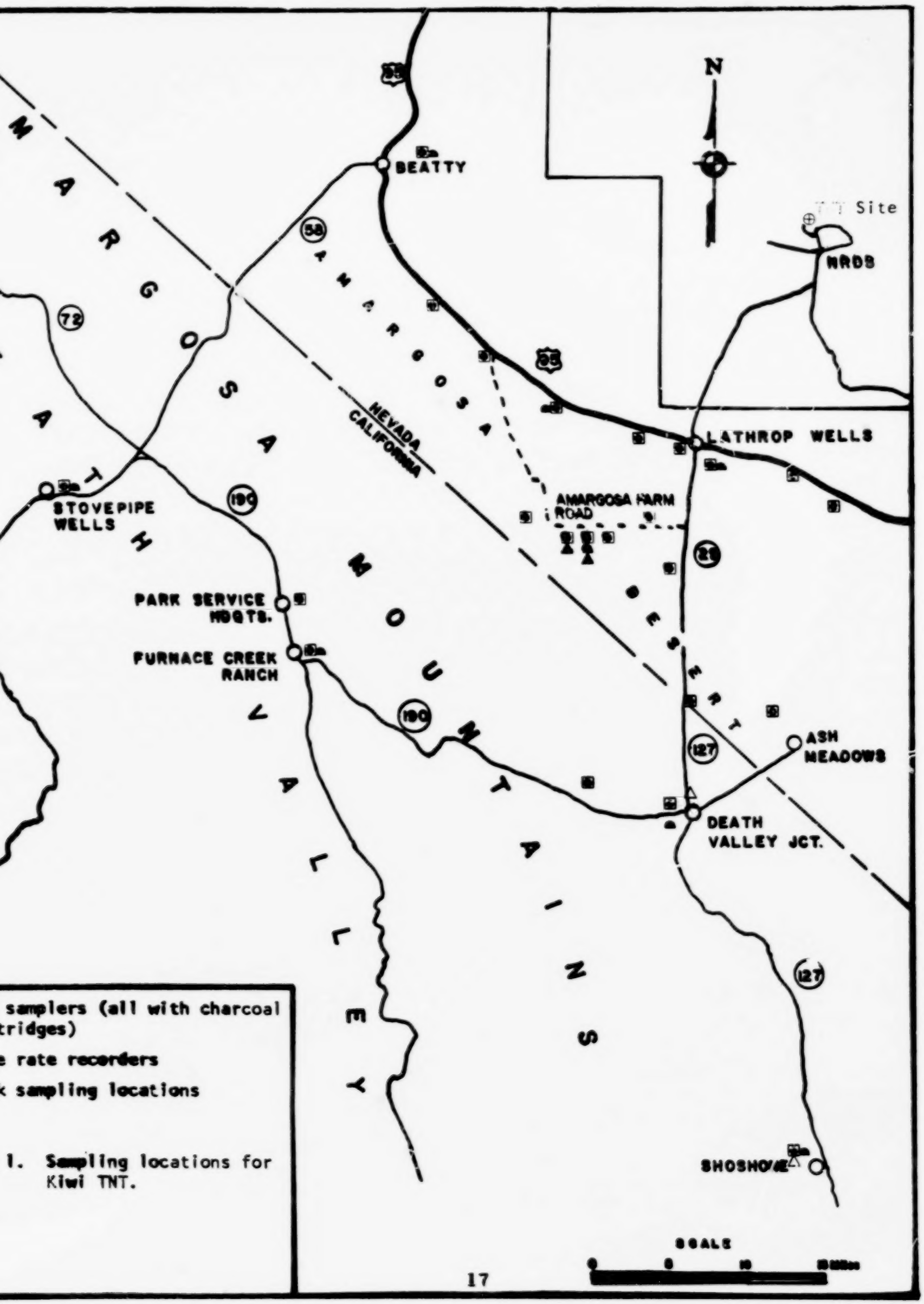
5.0 mi W of Hwy. 29						C	ND	24	23	59
Amargosa Farm Road 6.0 mi W of Hwy. 29	0810-1440	125	ND	7.3×10^2	1.71×10^7	P		(No analysis)		
						C	ND	9.6	60	40
Amargosa Farm Road 6.5 mi W of Hwy. 29	0810-1508	136	---	5.7×10^2	1.43×10^7	P	ND	61	61	ND
						C	ND	1.3	12	7.6
Amargosa Farm Road 9.3 mi W of Hwy. 29	0825-1530	160	ND	92	2.35×10^6	P	ND	11	9.5	ND
						C	ND	1.3	7.3	2.3
On Hwy. 29, 15.3 mi S of Lathrop Wells	0845-1535	136	---	1.1×10^3	2.71×10^7	P	ND	1.2×10^2	1.5×10^2	26
						C	ND	2.8	28	15
Death Valley Jct.	0650-1510	168	---	2.4×10^3	7.20×10^7	P	ND	2.5×10^2	2.7×10^2	34
						C	ND	10	8.0	34
On Hwy. 190, 7.5 mi W of Death Val. Jct.	1310-1500	30	ND	2.7×10^4	1.78×10^8	P	ND	3.3×10^3	3.1×10^3	5.3×10^2
						C	ND	20	5.0×10^2	3.3×10^2

*P=prefilter C=charcoal cartridge ND=not detectable

IV. CONCLUSIONS

The maximum dose rate of 70 mr/hr encountered off the NRDS yielded a 5.7 mr external gamma exposure dose. This may be compared to the Standards for Radiation Protection given in AEC Manual Chapter 0524, which was applicable to Kiwi TNT. The protection guide for whole body exposure to an individual is 500 millirem/year. Since one milliroentgen produces approximately one millirem biological dose, it can be seen that off-site exposure due to cloud passage presented only a small contribution to the allowable dose inventory.

The maximum measured thyroid dose of 3.3 millirad was obtained by the PHS monitor located 1.5 miles west of Lathrop Wells. The Standards for Radiation Protection for thyroid exposure to an individual is 1500 millirem/year. One millirad of gamma radiation corresponds to approximately one millirem biological dose. Although no thyroid measurements were made of persons residing in Lathrop Wells, the comparison of gross beta inhalation exposure at the two locations (Lathrop Wells and 1.5 miles west on Highway 95) indicate an inhaled thyroid dose of at least two orders of magnitude less at Lathrop Wells.

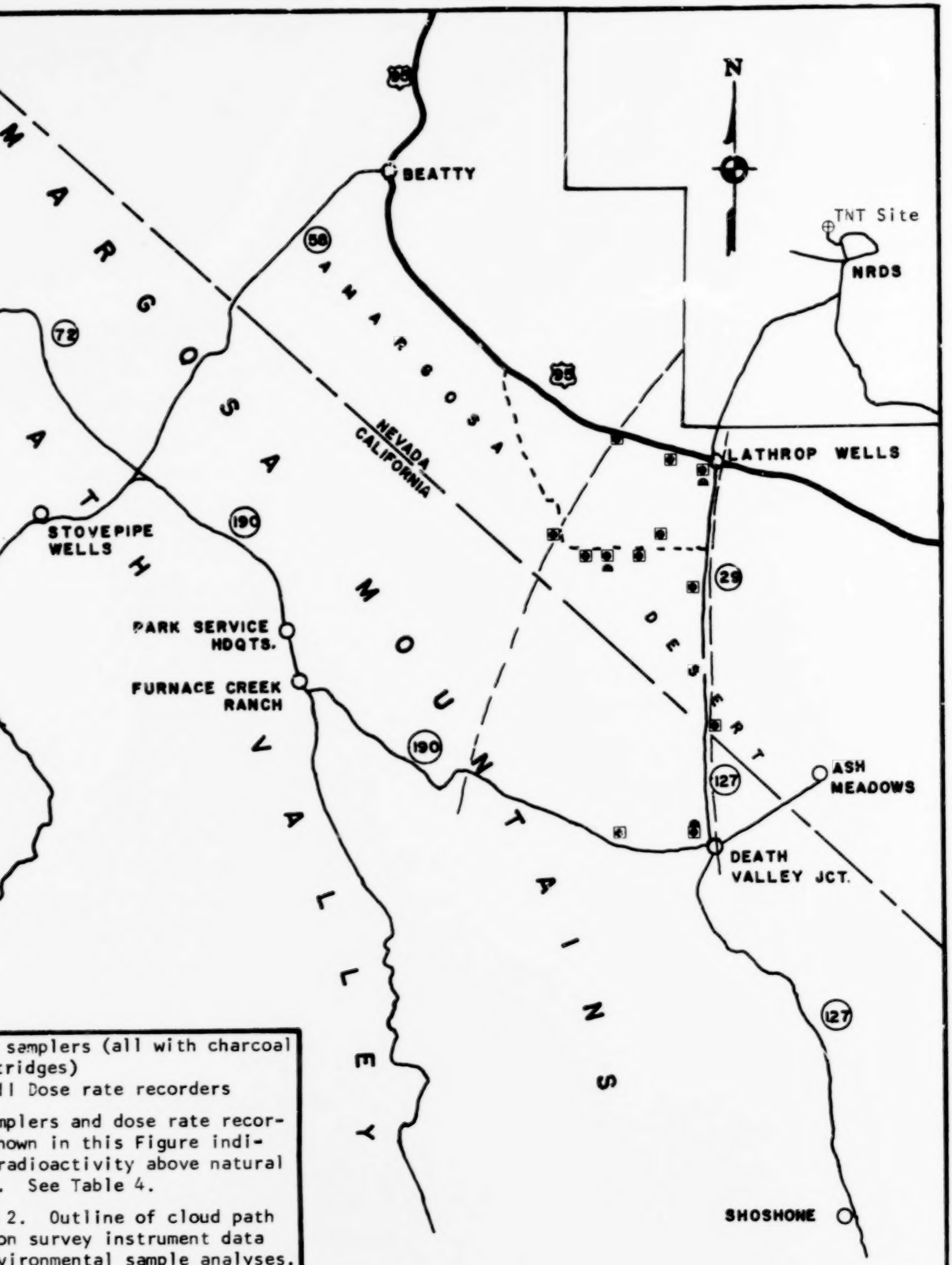


samplers (all with charcoal tridges)

e rate recorders

k sampling locations

1. Sampling locations for Kiwi TNT.



samplers (all with charcoal
tridges)
ll Dose rate recorders

mplers and dose rate recor-
hown in this Figure indi-
radioactivity above natural
. See Table 4.

2. Outline of cloud path
on survey instrument data
vironmental sample analyses.

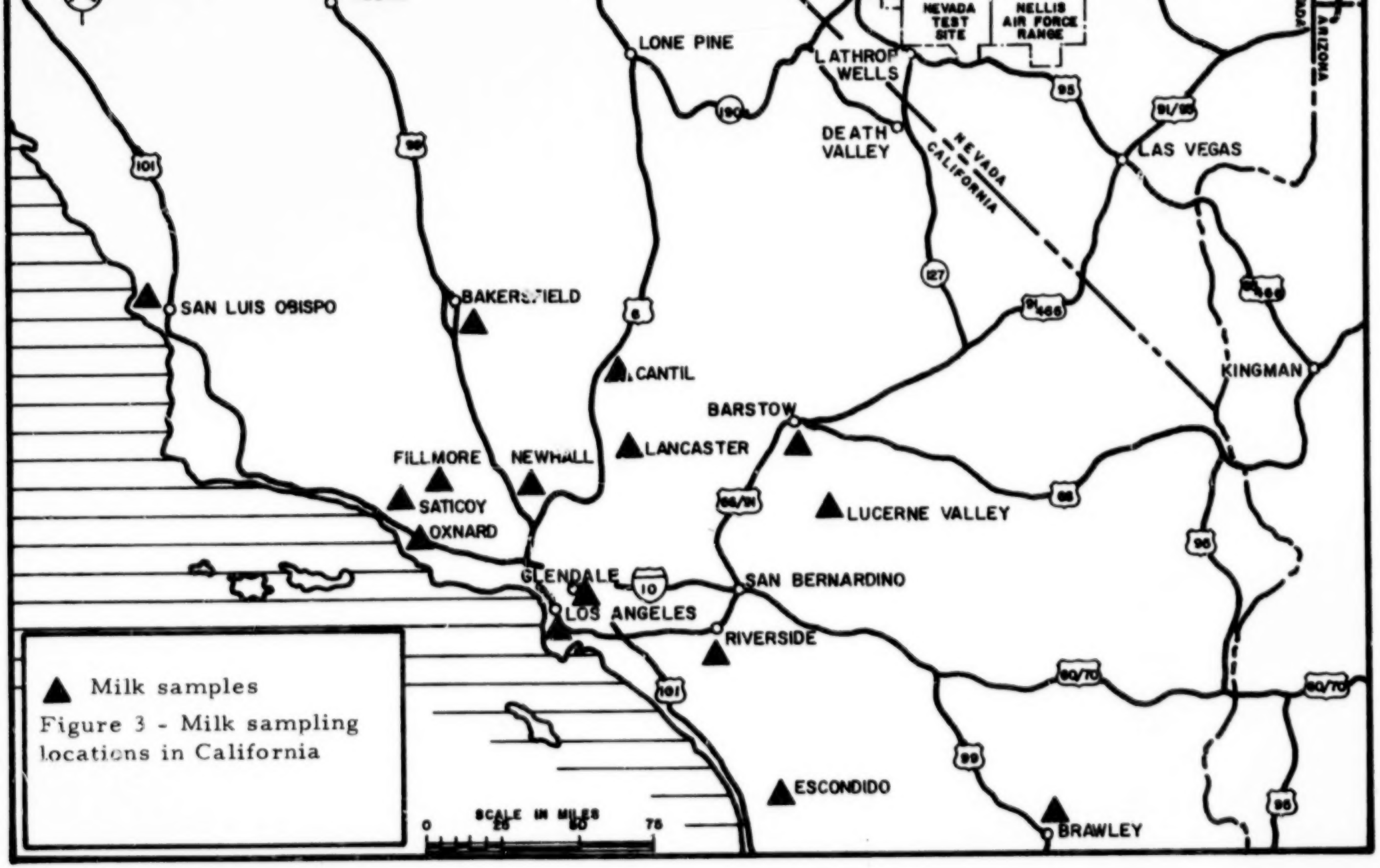
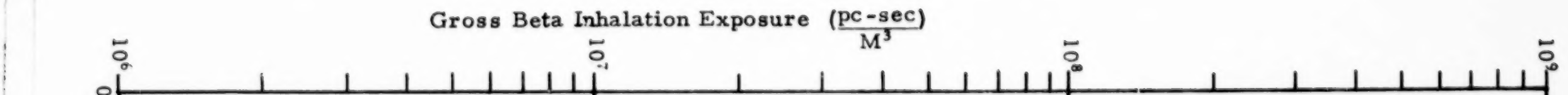
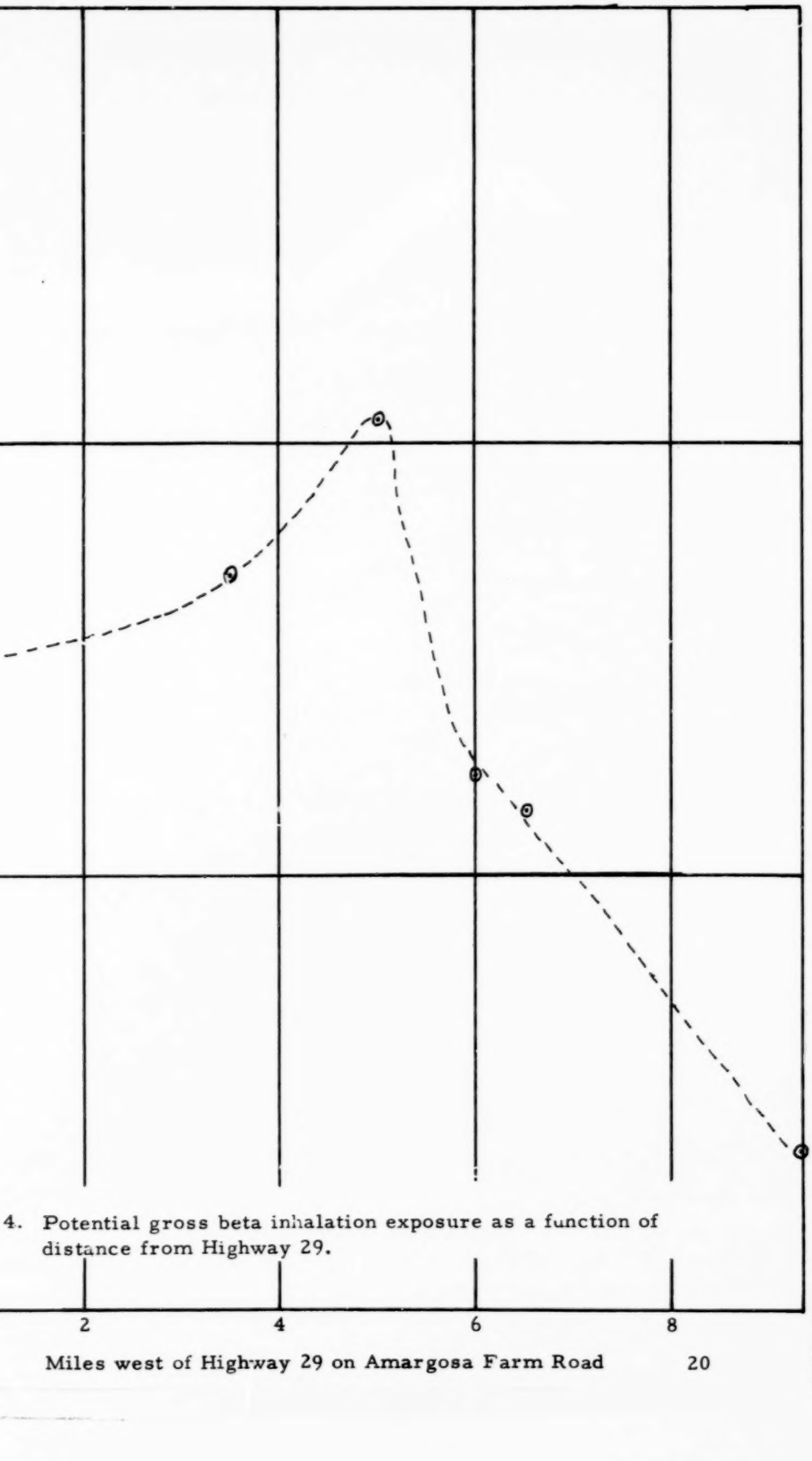


Figure 3 - Milk sampling locations in California





4. Potential gross beta inhalation exposure as a function of distance from Highway 29.

DA
3